

ELECTRONIC FUNDAMENTALS

EXPERIMENT LESSON 31

FREQUENCY-CONVERSION EXPERIMENTS



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Experiment Lesson 31

INTRODUCTION

The basis of the superheterodyne receiver is the frequency conversion process. The input to the frequency converter is an amplitude-modulated radio-frequency signal. This signal is made up of a carrier signal on which is superimposed the desired audio signal, as shown in Fig. 31-1. The output of the frequency converter consists of several carrier signals whose frequency is different, but which have the same desired audio signal superimposed on them. Only the *carrier* frequency is changed by the conversion process. The figure shows only the difference frequency output. As described in the Theory Lesson, the signal at the difference frequency is the one selected by the tuned circuits.

This frequency is the intermediate frequency of the receiver. The difference frequency is always the same for all signals, because the local oscillator is always tuned above the incoming signal by an amount equal to the intermediate frequency.

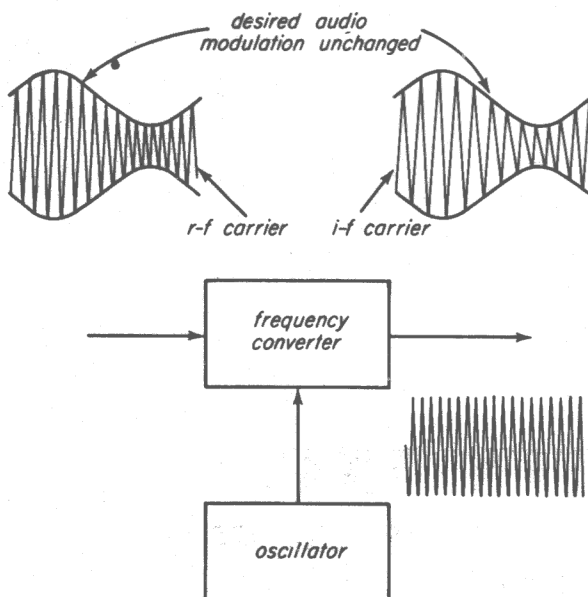


Fig. 31-1

In order for the frequency conversion of mixing action to take place, there must be a nonlinear impedance in the circuit. This will be demonstrated by one of the experiments.

In all of the receivers you have previously built, the desired station was selected by the tuned circuit of the input stage. To put it more generally, the desired signal is selected by the tuning of the circuits that the signal passes through. In the superheterodyne receiver, the signal is not selected in this way. The signal that is received is selected by the frequency of the oscillator signal. This will also be demonstrated in an experiment. This selection is a result of the very high selectivity of the i-f tuned circuits compared to the r-f tuned circuits.

Finally, this lesson will demonstrate the susceptibility of the superheterodyne type of receiver to a type of interference known as image interference. Later experiments will show, however, that this interference can be kept to a minimum.

EQUIPMENT NEEDED

Radio receiver chassis

Signal generator

Antenna pickup coil

Multi meter

Crystal diode holder

Two 100 k-ohm $\frac{1}{2}$ watt resistors

Crystal diode (removed temporarily from multimeter)

Caution: The multimeter should not be used to measure a-c voltages while one of the

diodes is removed. Damage to the other diode may result if voltages in excess of 50 volts are applied to the meter. Put some kind of tag on your meter to remind you of this until you replace the diode. The meter can still be used for d-c voltage and resistance measurements.

INFORMATION

In previous experiments, the intermediate frequency transformers were aligned to 465 kc. This was done for convenience in obtaining the response curves of the i-f transformers. Although an intermediate frequency of 465 kc can and has been used for broadcast receiver, current practice is to standardize on 455 kc for the intermediate frequency. Before the frequency conversion experiments are begun, the i-f transformers will be realigned to 455 kc.

In the Experiment Lesson dealing with the construction of the signal generator, a procedure was given for calibrating the signal generator. This procedure consisted of comparing the frequency of the signal generator r-f output with the frequency of a radio broadcast station, and adjusting the trimmer until the frequency of the signal generator output agreed with the scale marking at the position to which the dial pointer was set. Using this procedure results in the frequency of the r-f output being very close to the frequency indicated by the pointer over the entire Band B (broadcast band) scale.

However, when the signal generator is used at points other than the one used for calibration, the actual frequency of the output signal will not be exactly the same as the frequency shown by the pointer. This may be expected not only in your signal generator, but even in more expensive commercial equipment of this type. This calibration error is of no significance in radio servicing work. For example, a receiver aligned to an intermediate frequency of 465 kc will work just as well as when it is aligned to 455 kc, as long as all the i-f circuits are aligned to the same frequency, and the r-f alignment is properly done, as explained later.

This limitation of signal generators is well known. In laboratory type equipment, *crystal*

calibrators are used in conjunction with a signal generator to obtain r-f signals whose frequency is precisely known. To take the place of such equipment, we will describe a procedure for using broadcast stations to locate the point on the signal generator scale at which the output frequency is 455 kc. To do this, the student must be able to receive two broadcast stations that are separated in frequency by about 400 kc - 500 kc, such as one station at about 600 kc, and another at about 1,000 kc. If you cannot receive such a combination of stations at your location, don't be concerned. The calibration of the student signal generator scale is *very close* (better than ± 5 percent on the A band) and will be more than accurate for the majority of purposes. This procedure is given because it is a good technique to know, and because alignment of the i-f circuits to exactly 455 kc will make the numerical results in this experiment come out closer to the results predicted by theory. For ordinary alignment work it is very adequate to just turn the pointer to 455 on the scale, and assume the output signal is a 455 kc signal.

JOB 31-1

To prepare the chassis for the frequency conversion experiments.

Procedure.

Step 1. Disconnect the red lead of T_1 from lug 2 of TS-J, cut it to the proper length, and connect it to lug 3 of TS-C, as shown in Fig. 31-2.

Step 2. Disconnect the blue lead of T_1 from lug 3 of TS-J, cut it to the proper length, and connect it to pin 3 of the 6SA7 tube.

Step 3. Connect a 100,000-ohm resistor from pin 8 (signal grid) of the 6SA7 tube to the ground lug on this tube socket. This is a temporary connection, so do not cut the leads of this resistor.

Step 4. Connect a short piece of wire between pin 1 of this tube socket, and pin 7. This grounds the external metal shield of the tube.

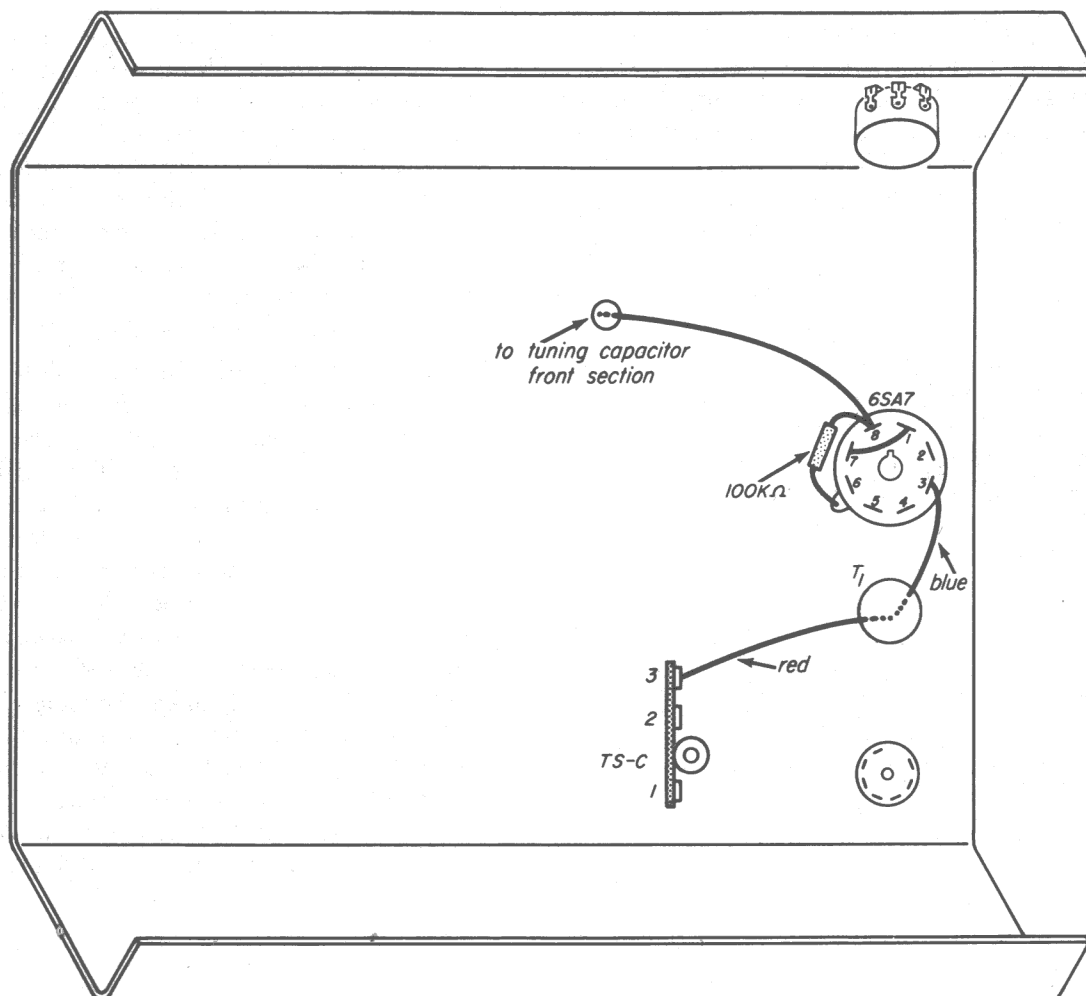


Fig. 31-2

Step 5. At lug 1 of TS-G disconnect the lead from the tuning capacitor, and temporarily connect it to the signal grid (pin 8) of the 6SA7 tube.

Step 6. Slip the pickup coil over the antenna coil. Check to see that the other lead of the pickup coil is soldered to the ground terminal of the antenna coil, as shown in Fig. 31-3. Do not connect the external antenna to the pickup coil.

The new circuit produced by this wiring is shown in the schematic diagram of Fig. 31-3.

JOB 31-2

To test the wiring of the 6SA7 converter tube by voltage measurements. Voltage checks are also made on the i-f amplifier, since the current drawn by the converter tube changes the operating voltages of the i-f tube.

Procedure.

Step 1. Check to see that all the tubes are inserted in their proper sockets. The r-f tube has no d-c voltages applied to it, and may be left out.

Step 2. Turn on the receiver and allow the tubes to warm up.

Step 3. Set up the multimeter to the 500 VDC scale, and measure the various voltages called for in Table A. Turn the meter range switch cautiously to a lower range where necessary, and be sure to return it to the highest d-c range when you are finished. Compare your readings with the voltages given. If there are any voltages that differ by much more than 20 percent from the voltages given, locate the trouble before proceeding by comparing your chassis with the wiring diagrams of Figs. 31-2 and the schematic of 31-3.

TABLE A — D-C VOLTAGES

TABLE A — D-C VOLTAGES				
	I-F Amplifier		Converter	
	Measured (Volts)	Given (Volts)	Measured (Volts)	Given (Volts)
Plate	235 5	210	235 3	210
Screen	100 6	100	100 4	100
Control Grid	0 1	0*	0 4	0*
Cathode	7	1.8	0 6	0
Oscillator Grid		—	-12 5	-10 **

* May be slightly negative, depending on signal pickup.

**At minimum setting of tuning capacitor.

JOB 31-3

To calibrate the signal generator at 455 kc.

Information. The method by which we calibrate the signal generator to 455 kc is to produce an intermediate frequency signal *in the receiver* that we know is exactly 455 kc. This receiver signal will then be compared with the signal generator output, and the generator adjusted to zero-beat the two signals. In order to produce an intermediate frequency signal at exactly 455 kc, we need only apply to the converter two signals whose frequencies are exactly 455 kc apart. Then the difference frequency in the converter output will be exactly 455 kc.

One of the two signals used for this purpose is a broadcast station of known frequency, and the other is the receiver oscillator output. The oscillator is set up so that

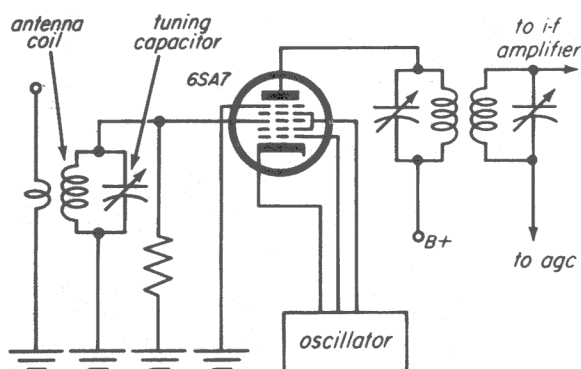


Fig. 31-3

is it exactly 455 kc above the station. Then the broadcast station and the oscillator output are both applied to the converter tube. By mixing action, the difference frequency is produced, and this frequency is exactly 455 kc.

In order to set up the oscillator accurately, we first make sure the signal generator is accurate at the oscillator frequency. This is done by zero-beating the signal generator with another broadcast station whose frequency is nearly equal to the sum of 455 kc plus the frequency of the first broadcast station. Let's illustrate the method with a numerical example.

From the broadcast stations that can be picked up at your location, choose two that are about 455 kc apart. You probably will not be able to find two stations that are exactly 455 kc apart, but if they are anywhere from 400 kc to 500 kc apart, good results will be gotten. Let's say that the two stations are at 1,050 kc and 570 kc. The sum of the lower frequency (570 kc) and 455 kc should be very close to the higher frequency (1,050 kc). In this case this sum is 1,025 kc, which is pretty good for this purpose. We use the station at 1,050 kc to calibrate the signal generator on Band B. Because the required oscillator frequency (1,025 kc) is so close to the frequency at which the generator was calibrated (1,050 kc), we can safely assume that when the pointer is set to 1,025 kc, it is putting out 1,025 kc. We can then use the signal generator to set up the oscillator to 1,025 kc.

With the oscillator at exactly 1,025 kc, and the incoming signal known to be exactly 570 kc, we know that the difference frequency produced in the mixer plate circuit is exactly 455 kc. This signal can now be used to calibrate the signal generator to exactly 455 kc.

Be sure that you understand the principles of this method before you attempt to perform the calibration.

Procedure.

In the previous experiments, you used a pickup coil designed for picking up a portion

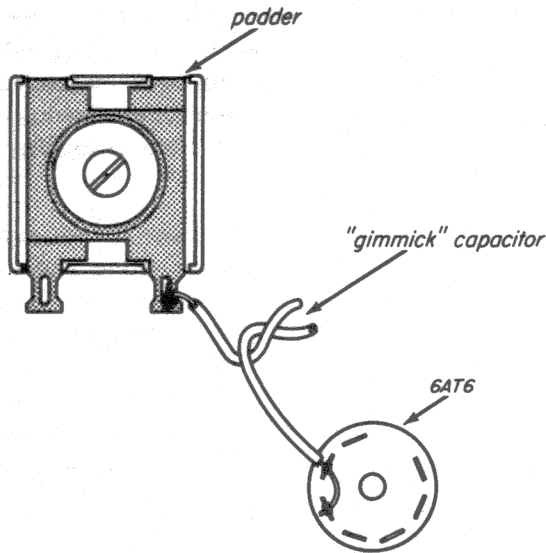


Fig. 31-4

of the oscillator output without disturbing the oscillator circuit. In this experiment you will learn to use another technique for doing this.

Step 1. Cut a 2-inch piece of hookup wire, strip the insulation from each end, and connect it from pin 6 (diode plate) of the 6AT6 tube to terminal 1 of the padder capacitor.

Step 2. Cut the wire in the middle, and then twist the cut ends together for about $\frac{1}{2}$ turn, as shown in Fig. 31-4. This produces a very small capacitor, which can be used for taking out a small amount of signal with a minimum of disturbance to the oscillator.

Step 3. Connect your antenna to the ungrounded lead of the pick-up coil.

Step 4. Cut off a 3- or 4-inch piece of hook-up wire. Strip $\frac{1}{4}$ -inch of insulation from one end. Wrap this piece of wire around the antenna lead near the chassis, making 3 or 4 turns, as shown in Fig. 31-5. Connect the hot alligator clip to the bare end of the hook-up wire, and the ground clip to the receiver chassis.

Step 5. Turn on the receiver and signal generator and allow the tubes to warm up.

Step 6. Tune the variable capacitor through its range slowly and note all the stations which can be received.

Step 7. Select two stations that are about 455 kc apart, as explained above. Identify the frequency of each station, either by listening for the station identification announcement, or by comparing the program material with the newspaper listing. Be sure you have correctly identified both stations.

Care must be taken to positively identify the stations.

We will refer to the station that is higher in frequency as Station A. Record the frequency here:

KING
1090 kc

(Station A) 1090

The lower frequency station will be referred to as Station B. Record the frequency here:

KGDN
630 kc

(Station B)

Tune the variable capacitor to receive Station A. Make sure the station is actually the one you think it is.

Step 8. Set the signal-generator band switch to Band B, and adjust the dial pointer knob until a zero beat is produced between the

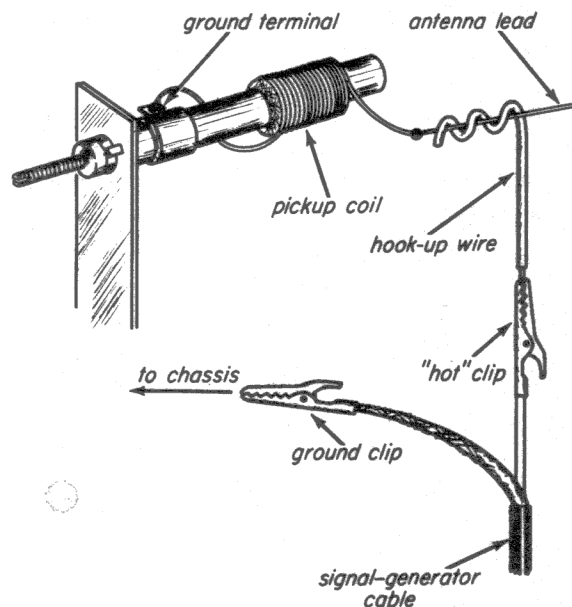


Fig. 31-5

signal generator output and the incoming broadcast signal. This zero beat should occur with the pointer indicating very nearly the frequency of the broadcast station. If not, you are probably identifying the broadcast station incorrectly.

Step 9. If the zero beat does not occur at or very close to the frequency of the broadcast station, set the pointer to exactly the frequency of Station A, and turn the signal generator trimmer to produce zero beat. If the zero beat in Step 7 occurred with the pointer showing a higher frequency, turn the trimmer very slightly clockwise; if the beat occurred with the pointer showing a lower frequency, turn the trimmer slightly counter-clockwise.

Step 10. Turn the receiver tuning capacitor to pick up Station B. Again, make sure that the station you are listening to is really the one you think it is. The best way is to listen for the station announcement. Positive identification is even more important for Station B, because of the possibility of image responses.

Step 11. Calculate the oscillator frequency of Station B. (Add 455 kc to the frequency of Station B.) Record it here:

$$\begin{array}{r} 630 \\ 455 \\ \hline 1085 \end{array} \text{ kc}$$

Station B oscillator frequency

The required Station B oscillator frequency should be very close to the frequency of Station A at which the signal generator has just been calibrated.

Step 12. Set the pointer to the frequency calculated in Step 11 above. Estimate the correct position as carefully as you can. Since this frequency setting is very close to the point where the signal generator has been calibrated, you can assume that the signal generator is very accurate in this region of the dial scale.

Step 13. Connect the signal generator to pin 5 (diode plate) of the 6AT6 tube. This

will reduce the sound considerably, but by turning the volume control up toward maximum the station can still be heard weakly. Now both the oscillator output and the signal generator output are applied to the second detector.

Step 14. Turn the variable capacitor slightly to produce a zero beat between the oscillator and signal generator signal. When this is done, the oscillator is set to exactly 455 kc above the incoming Station B. The change in tuning should be very slight, and Station B should be heard at all times. (If the sound completely disappears when the signal generator is connected as in Step 12, disconnect the signal generator after zero beat is obtained and make sure you are still receiving Station B.)

Step 15. Connect the hot lead of the signal generator around the insulation of the blue lead of T_1 .

Since the oscillator signal has been adjusted so that its frequency is exactly 455 kc above Station B, the difference frequency produced in the mixer plate circuit is exactly 455 kc.

Set the signal generator to band A, and turn the pointer to the vicinity of 455 kc. Then adjust it carefully to produce zero beat.

Step 16. Mark the position of the pointer, or record its position on the logging scale as shown in Fig. 31-6. One convenient way to

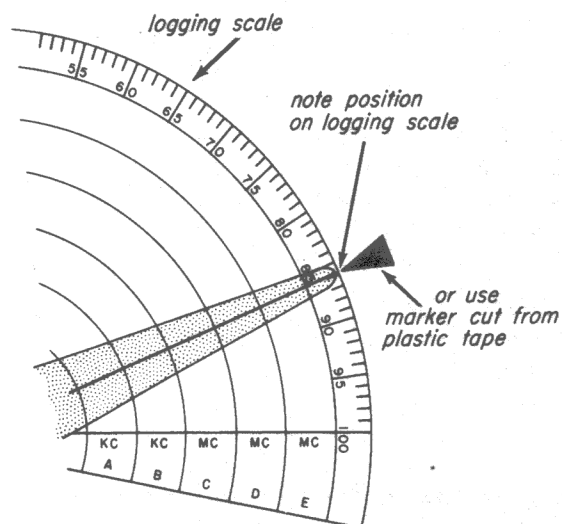


Fig. 31-6

mark its position to cut a small triangle out of plastic tape, and stick it carefully on the front panel to indicate the position of the pointer at which 455 kc is obtained.

Step 17. Turn off the receiver. Disconnect the signal generator. Unsolder the two short pieces of wire used to form the "gimmick" capacitor.

JOB 31-4

To align the i-f transformers to resonance at 455 kc.

Procedure.

Using the procedure given in Job. 29-3, Experiment Lesson 29, align the i-f transformers to resonance at 455 kc, using the calibrated 455-kc point on the signal generator determined earlier.

EXPERIMENT 31-1

To show that mixing action will not take place unless there is a nonlinear impedance in the circuit.

Procedure.

Step 1. Make another twisted wire "gimmick" capacitor by connecting a $4\frac{1}{2}$ -inch piece of hookup wire between the oscillator grid (pin 5 of the 6SA7) and the diode detector plate (pin 6 of 6AT6). Cut the wire in the center, and twist the cut ends together for about two turns.

Step 2. Disconnect at pin 3 of the 6SA7 tube, the blue wire from T_1 , and tape it up to prevent shorting while it is temporarily disconnected.

Step 3. Disconnect at the signal grid (pin 8 of the 6SA7) the wire from the tuning capacitor and connect it to pin 1 of 6BA6 r-f tube.

Step 4. Connect the signal generator hot lead to the diode-detector plate (pin 5 of the 6AT6), and the ground lead to the chassis.

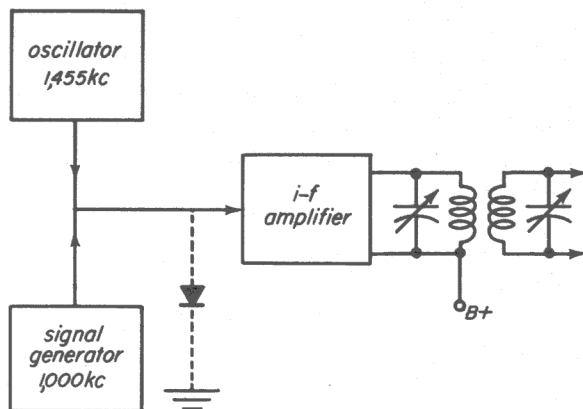


Fig. 31-7

Step 5. Turn on the receiver and signal generator and allow the tubes to warm up. Set the signal generator to band B, and about 1,455 kc.

Step 6. Set the tuning capacitor to about the midpoint of its range, and then rotate it back and forth to zero-beat the receiver oscillator with the signal generator. (When the tuning capacitor is set to its midpoint, the receiver oscillator frequency is about 1,455 kc.)

Step 7. Turn off the receiver. Disconnect, at the diode detector plate, the lead of the "gimmick" capacitor and connect it to pin 1 of the 6BA6 i-f tube so as to couple the oscillator signal to the grid of the i-f tube.

Step 8. Connect the crystal-diode holder from pin 1 of the i-f tube to chassis. Do not put the crystal in the holder.

Step 9. At lug 1 of TS-C, disconnect the black lead from i-f transformer T_1 , and connect it temporarily to lug 3 of TS-J.

Step 10. Connect a 100 k-ohm resistor from lug 3 of TS-J to lug 2 of this terminal strip.

Step 11. Connect the hot-lead alligator clip of the signal generator around the insulation of the "gimmick" capacitor lead near the grid (pin 1) of the i-f tube.

The experimental set up is shown in block-diagram form in Fig. 31-7, and schematically in Fig. 31-8.

Step 12. Turn on the receiver and signal

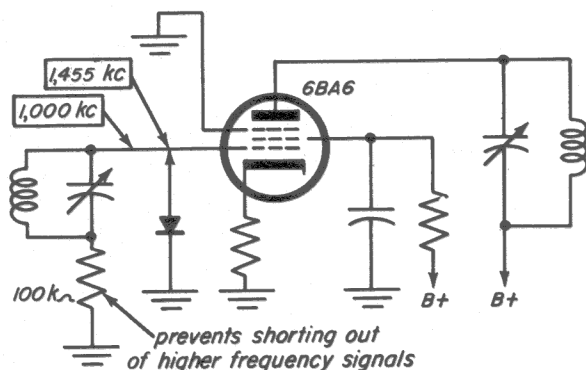


Fig. 31-8

generator and allow the tubes to warm up.

Step 13. Turn on the AF OUT/INT MOD switch of the signal generator. See the RF ATTEN control to about position 2 on the r-f output scale. Set the receiver volume control to its mid-position.

Step 14. Move the signal generator pointer back and forth from about 900 kc to 1,100 kc. Is any output heard from the loudspeaker?

Note: If any signal is heard at this point, it is because the i-f amplifier is being overdriven. Reduce the r-f output from the signal generator slightly until no signal is heard.

Step 15. Put the crystal diode into the holder, so that the crystal is connected from grid to ground. Again, move the signal generator back and forth from 900 to 1,100 kc. Now is any signal heard in the loudspeaker? Why?

Step 16. Remove the crystal diode, and then, using a screwdriver, short the cathode (pin 7) of the 6BA6 tube to ground. Again, move the signal generator back and forth between 900 and 1,100 kc. Is signal heard in the loudspeaker? Why?

Step 17. Turn off the receiver, disconnect the signal generator, and disconnect the "gimmick" capacitor, and the crystal diode holder. Replace the crystal diode in the multimeter.

Step 18. Return the black lead of T_1 to lug 1 of TS-C.

Step 19. Disconnect and put aside the 100 k-ohm resistor across TS-J.

Step 20. Return the blue lead of T_1 to pin 3 of the 6SA7.

What do these experiments show about the need for a nonlinear impedance to produce mixing action?

Discussion. This experiment shows that in order to obtain mixing action the two signals to be mixed must be present in a circuit that contains a nonlinear impedance.

No signal is heard when the two signals are applied to the grid of the 6BA6 without the crystal diode because there is no nonlinear impedance in the circuit. The 6BA6 is biased so as to operate near the middle of the linear portion of its characteristic curve. Even though the characteristic curve of the tube is nonlinear, the signal is very small, so that the positive and negative halves of the signal are amplified equally. No new frequencies are produced, and no new signal is heard in the output. The crystal diode is a nonlinear impedance because it conducts current in only one direction. When the crystal diode is connected in the circuit as is shown in Fig. 31-7, it shorts out either the positive or negative half cycle (depending on which way it is connected) of the incoming signals. The result of this distortion is to produce various new frequencies, one of which is the difference frequency that is used as the intermediate frequency.

Completely removing the bias from the 6BA6 tube by shorting the cathode to ground also produces an output because it turns the tube into a nonlinear device by causing it to operate near the bend of its characteristic curve.

When the tube is operated at this point of the characteristic curve, the positive halves of the input signal are not amplified as much as the negative halves. The resulting distortion produces new frequencies, including the intermediate frequency, just as in the case of the crystal diode.

The 100 k-ohm resistor is inserted between the grid of the i-f tube and ground as shown in Fig. 31-8 to prevent shorting out of the 1,455 and 1,000 kc (approximate) signals

applied to the grid. Since the i-f transformer in the grid circuit is tuned to 455 kc, all signals at other frequencies would be shorted out. The resistor has a fixed resistance of 100 k-ohms to all frequencies.

EXPERIMENT 31-2

To learn that in a superheterodyne receiver the broadcast stations are selected by varying the oscillator frequency.

Procedure.

Step 1. Connect the external antenna to the converter grid (pin 8 of the 6SA7 tube).

Step 2. Turn on the receiver and allow the tubes to warm up.

Step 3. Tune through the broadcast band, and select 3 or 4 broadcast stations that come in well at your location. Make a note of their frequencies.

Step 4. Turn off the receiver, and at pin 5 of the 6SA7 tube, disconnect the 50- μ f capacitor. Bend the capacitor up out of the way.

Step 5. Connect the signal-generator hot lead to pin 5 of the converter tube, and the ground clip to a chassis tie point near the converter tube. Arrange the alligator clips carefully so that they do not short to each other or to other wiring. The signal generator will now take the place of the receiver oscillator.

Step 6. Turn on the receiver and signal generator and allow the tubes to warm up. Set the r-f output control to maximum, and turn the modulation off.

Step 7. Tune the signal generator *very slowly* over Band B. Do you receive stations? Does changing the signal generator frequency cause different stations to be received? Why?

Step 8. Choose one of the stations that you selected in Step 3 above. We will refer to this station as Station C. Add and subtract 455 kc from the station frequency. Note your re-

sults here:

$$\begin{array}{r} 1090 \\ 455 \\ \hline 635 \end{array} \quad \text{kc}$$

$$\begin{array}{r} 1090 \\ 455 \\ \hline 1545 \end{array} \quad \text{kc}$$

Step 9. Set the signal generator to one of the frequencies determined above. Make sure the band switch is set to the proper band.

Step 10. Rotate the signal generator pointer back and forth slightly about this setting. Do you receive station C?

Step 11. Set your signal generator to the higher of the two frequencies determined in Step 8. Rotate the signal generator pointer back and forth slightly about this dial setting. Do you also receive station C? Why?

Step 12. Repeat Steps 8 through 11 for a number of different broadcast stations.

Step 13. Turn off the receiver. Disconnect the antenna from pin 8 of the 6SA7 tube. Reconnect the 50- μ f capacitor to pin 5.

Discussion. This experiment illustrates a very important characteristic of the superheterodyne receiver. This characteristic should be understood in order to perform the r-f alignment of such receivers properly. In the superheterodyne receiver, it is the oscillator frequency that selects the station that passes through the receiver and is heard in the loudspeaker. Because of the relatively narrow bandpass of the i-f transformers, only signals at 455 kc will pass through the i-f stages to the detector. The tuning of the oscillator determines which incoming signal will be converted down to 455 kc. Thus, if the oscillator is set to produce 1,455 kc, an incoming signal at 1,000 kc will be converted down to 455 kc, and this station at 1,000 kc is the one that will be heard. If the oscillator is lowered to 1,355 kc, an incoming signal at 900 kc will be converted down to 455 kc, and this station at 900 kc is the one that is heard. Unlike tuned radio frequency receivers, the r-f tuned cir-

KING - 1600 - 1090
KOMO - 1400

citus have little control over the signal that will be selected. The r-f tuned circuits serve to reduce the susceptibility of the receiver to image interference, as will be explained later.

As demonstrated in the experiment, the oscillator may be either 455 kc above or below the incoming signal. In either case, the intermediate frequency is produced and that particular incoming signal is heard. For practical reasons, the oscillator in broadcast band receivers is always above the incoming signal.

EXPERIMENT 31-3

To learn that the superheterodyne receiver is susceptible to a type of interference known as image interference.

Information. In the previous experiment, you saw that the oscillator frequency could be either above or below the frequency of the desired signal. Just as there are two possible oscillator frequencies that will produce the same intermediate frequency for a given station, there are two incoming signal frequencies that can produce the same intermediate frequency for a given oscillator setting. This is called image interference. For example, suppose the receiver is set to receive a station at 1,000 kc, as in Fig. 31-9. The oscillator would then be adjusted to 1,455 kc. The difference between them is the intermediate frequency. Suppose however, that a signal whose frequency is equal to the oscillator frequency plus the i-f frequency, or 1,910 kc, reaches the grid of the converter. This signal will also beat with

the oscillator output to produce an i.f. of 455 kc. Both signals are able to pass through the receiver, and interference results. The i-f circuit cannot distinguish between these two signals.

Any signal whose frequency is higher than the oscillator frequency by the same amount that the desired signal is below the oscillator is capable of producing image interference. Thus the image signal is separated from the desired signal by twice the intermediate frequency.

It is also possible for other unwanted signals to be converted to the intermediate frequency and cause interference. These signals are at frequencies that are separated from the harmonics of the oscillator by the intermediate frequency. Thus, image interference may result from signals whose frequencies are:

1. 2nd harmonic of the oscillator plus the intermediate frequency.
2. 2nd harmonic of the oscillator minus the intermediate frequency.
3. 3rd harmonic of the oscillator plus the intermediate frequency.
4. 3rd harmonic of the oscillator minus the intermediate frequency and so on. This image interference becomes weaker as higher harmonics of the oscillator become involved. Also, as the frequency of the interfering signals are further removed from the wanted signal, it becomes easier to eliminate them

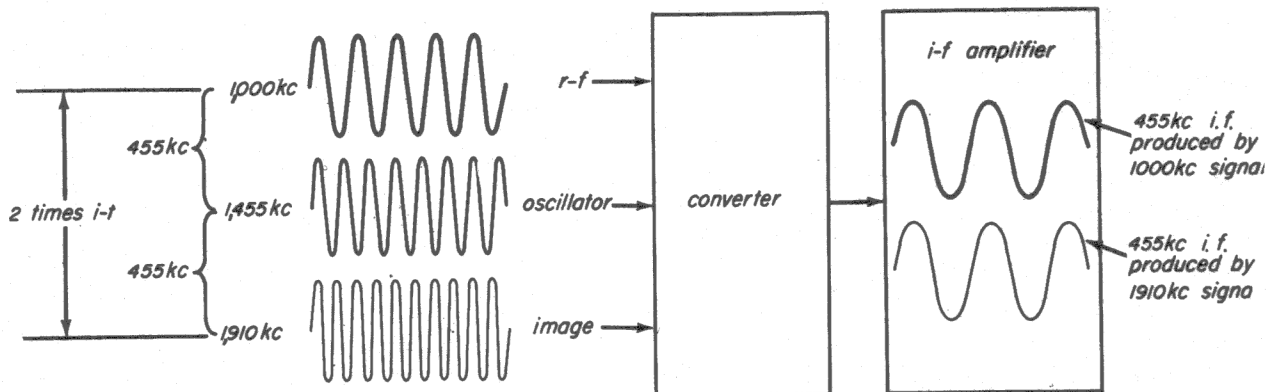


Fig. 31-9

by tuned circuits, as will be shown in a later experiment lesson.

Procedure.

Step 1. Assuming an incoming signal of 600 kc and an i.f. of 455 kc, calculate:

Oscillator frequency	<u>1055</u>	kc
Image frequency	<u>1510</u>	kc
Oscillator 2nd harmonic	<u>2110</u>	kc
Oscillator 2nd harmonic + i.f.	<u>2565</u>	kc
Oscillator 2nd harmonic - i.f.	<u>1655</u>	kc

Images

At which of these frequencies can image interference be expected?

Step 2. Connect the signal generator cable to the converter grid (pin 8 of the 6SA7) and chassis.

Step 3. Set up the multimeter to the 75 VAC range, and insert the positive lead in the OUTPUT jack. Connect the meter to the plate (pin 3) of the 6K6-GT tube and chassis.

Step 4. Turn on the receiver and signal generator and allow the tubes to warm up. Set the volume control to its midposition.

Step 5. Set the signal generator to Band B, 600 kc. Adjust the RF ATTEN control to approximately position 2 on the calibrated scale, and turn the modulation switch on.

Step 6. Tune the variable capacitor to pick up the signal generator output. There may be a number of points at which a signal is received. The loudest response is the correct one.

Step 7. Adjust the volume control to obtain about half-scale deflection on the meter.

Step 8. Slowly tune the signal generator to increase the frequency of the output, and note the first three frequencies at which a response is obtained. There may be many responses that will cause only a small deflection of the meter. They are due to the

signal generator beating with local broadcast stations reaching the converter grid. Disregard them. The responses to note are those which will give as much deflection as obtained in Step 7 above.

Record the three frequencies here:

<u>1510</u> 2110	kc	<u>1680</u> 2110	kc
<u>2600</u> 2565		kc	

How do they compare with the predicted image responses obtained in Step 1?

Step 9. Assuming an r-f signal of 1,000 kc and an i.f. of 455 kc, calculate:

Oscillator frequency	<u>1455</u>	kc
Image frequency	<u>1910</u>	kc
Oscillator 2nd harmonic	<u>2910</u>	kc
Oscillator 2nd harmonic + i.f.	<u>3365</u>	kc
Oscillator 2nd harmonic - i.f.	<u>2455</u>	kc

Images

Step 10. Set the signal generator to Band B, 1,000 kc. Adjust the RF ATTEN control to approximately position 2 on the calibrated scale, and turn the modulation switch on.

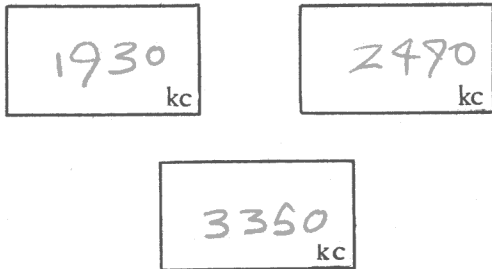
Step 11. Tune the variable capacitor to pick up the signal generator output. There may be a number of points where a signal is received. The loudest response is the correct one.

Step 12. Adjust the volume control to obtain about half-scale deflection on the meter.

Step 13. Slowly tune the signal generator to increase the frequency of the output, and note the first three frequencies at which a response is obtained. There may be many responses that will cause only a small deflection of the meter. They are due to the signal generator beating with local broad-

cast stations reaching the converter grid. Disregard them. The responses to note are those which will give as much deflection as obtained in Step 12 above.

Note the three frequencies here:



How do they compare with the predicted image responses obtained in Step 9?

Step 14. Adjust the signal generator to produce a 455-kc modulated signal. Note the meter response and compare it with Step 12.

HIGHER
Discussion. It should be noted that the response, as measured by the output meter, is about the same for the various image frequencies, and the i-f frequency as it is for the desired frequency. This is because the circuit, as it stands now, has no way of distinguishing between the various signals. However, as you will learn later on, when an r-f tuned circuit is added, the response to the desired frequency is increased, and the response to the undesired image frequencies is practically eliminated.

JOB 31-5

To prepare the chassis for the next Experiment Lesson.

Procedure.

Step 1. Rotate TS-J counterclockwise so that it is parallel with the sides of the chassis, as shown in Fig. 31-10.

Step 2. Connect a wire between lug 3 of TS-C and lug 1 of TS-J.

Step 3. Connect a wire between lug 1 of TS-C and lug 3 of TS-J.

Step 4. Disconnect the 0.05- μ f capacitor at lug 1 of TS-C, and connect it across lugs 3 and 2 of TS-J. This is a permanent connection, so cut the leads to the proper length.

Step 5. Remove the black lead of T_1 from lug 1 of TS-C, and connect it to lug 3 of TS-J.

Step 6. Disconnect the 100 k-ohm resistor from pin 8 of the 6SA7 tube and chassis. Connect it from lug 3 of TS-J to pin 8 of the 6SA7 tube. This is a permanent connection, so cut the leads to the proper length. Check your chassis against the complete schematic diagram at the end of the lesson.

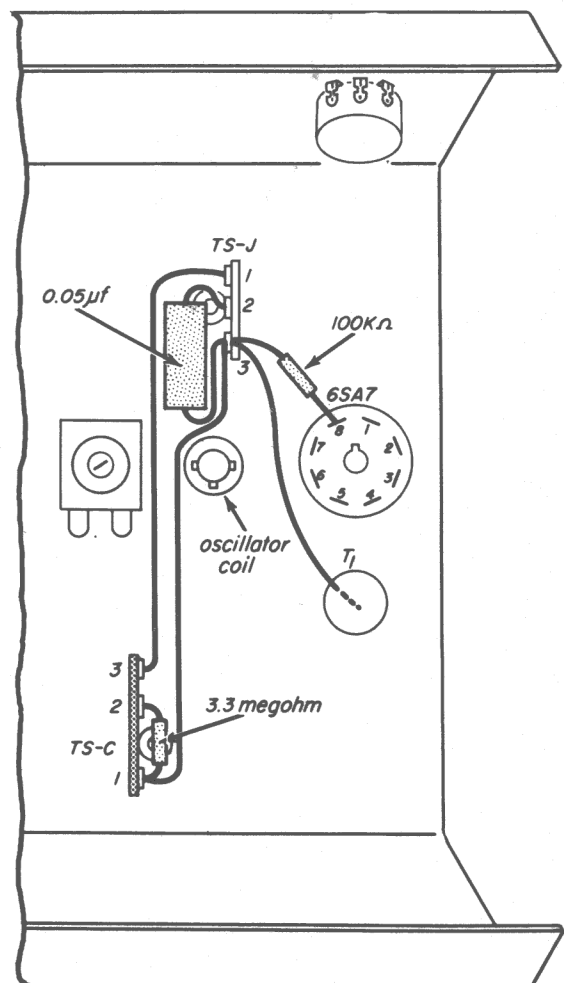
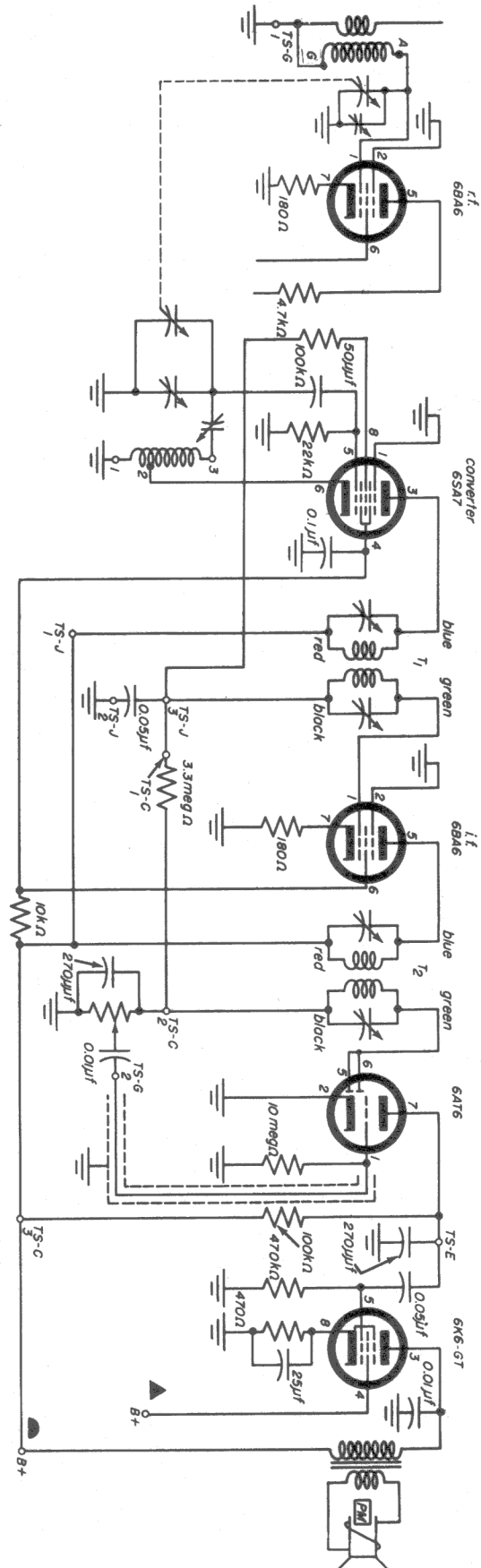


Fig. 31-10



Condition of Radio Receiver Chassis at End of Experiment Lesson 31